Space Technology Research Grants

Modular Joints for Soft Robots

Completed Technology Project (2014 - 2018)

Project Introduction

We propose to design, optimize, and build several modular soft robotic joints which have between 3 and 6 degrees of freedom (DOF). These designs will be lighter, have faster response times and larger workspaces than current rigid robotic joints, but will still produce comparable actuation forces. We will do this by implementing tensegrity concepts within the designs. The passive compliance that exists within tensegrity structures will allow the joints to enjoy the benefits associated with soft robots, namely the ability to function well in uncertain environments and operate safely alongside humans. The high number of degrees of freedom in each of the modular joints will reduce the number of joints required for high DOF robotic manipulators, which currently use series of single DOF actuators in most applications. Our designs will be focused on modularity so that they can be used in mechanical assemblies to produce lightweight, and powerful soft robots. In order to ensure the joints have large ranges of motion, we will perform an advanced nonlinear optimization of each of the joint's workspace with respect to its topology. NASA Tensegrity Robotics Toolkit, a tensegrity physics simulator developed by IRG, will be used to create physics simulations of the joints and test different controller designs. Once we are prepared to construct prototypes, Robonaut 2's current arm capabilities will be used as design criterion and therefore the joints will be designed to lift 20 pounds at a distance of 1.8 feet, and be able to achieve maximum end effector speeds of 2 m/s per second at this distance. Then we will build a high DOF manipulator which utilizes several of the joint prototypes within its mechanical structure and evaluate it's performance to demonstrate the effectiveness of the joints.

Anticipated Benefits

These designs will be lighter, have faster response times and larger workspaces than current rigid robotic joints, but will still produce comparable actuation forces.

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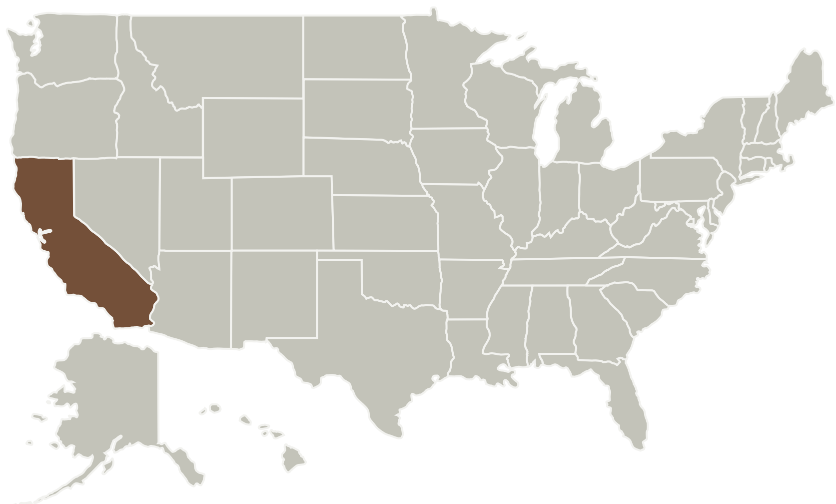
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of California-San Diego(UCSD)	Lead Organization	Academia	La Jolla, California

Primary U.S. Work Locations
California

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of California-San Diego (UCSD)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Thomas Bewley

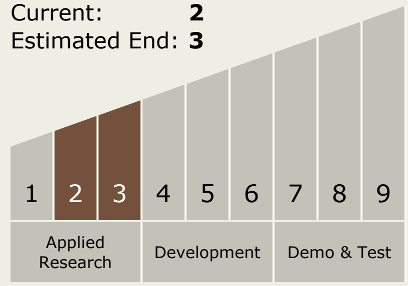
Co-Investigator:

Jeffrey M Friesen

Modular Joints for Soft Robots

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX07 Exploration Destination Systems
  - └ TX07.2 Mission Infrastructure, Sustainability, and Supportability
    - └ TX07.2.4 Micro-Gravity Construction and Assembly

Target Destinations

Mars, Others Inside the Solar System